Noise estimates on CS and RS baselines

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Noise estimates from raw visibility data

For an unpolarized sky and identical receivers the thermal noise in XX, XY, XY and YY should be identical.

Assumptions in analysis:
- 3C196 is intrinsically unpolarized → XX and YY flux equal to 83 Jy at 135 MHz.
- in the analysis I average XX and YY and XY and YX
- the noise should be derived from REAL part of the visibility (~ 1.5 x s.d. in amplitude)

Aspects to consider:
- sensitivity varies with time due to elevation change (→ use 2h around transit)
- structure in target field causes fluctuation in XX and YY → use 'long' term average
- variable leakage from XX , YY into XY, YX influence noise → use narrowish bands

Comments:
- XX and YY have slight noise differenced due to asymmetries in the design.
- NB: The 'infamous' factor 2 (see Smirnov, 2011). Normally: I = XX + YY so for a source of 83 Jy we expect 41.5 Jy in each polarization. But for the SEFD determination we assume the signal in XX and YY is due to a 83 Jy source !

Noise estimates from raw visibility data

In project LEA128 we now have ~ 15 epochs of data HBA(low) data on 3C196. Observations were taken between 18 Dec 2011 and 29 April 2011, mostly nighttime (till late March).

The S/N on the various baselines is rather variable from epoch to epoch: changes of a factor 1.5-2 are often observed !? This calls for a detailed investigation. Here I show data taken on 29 April 2011 (UT 1445-2018) and 19 March 2011 (UT

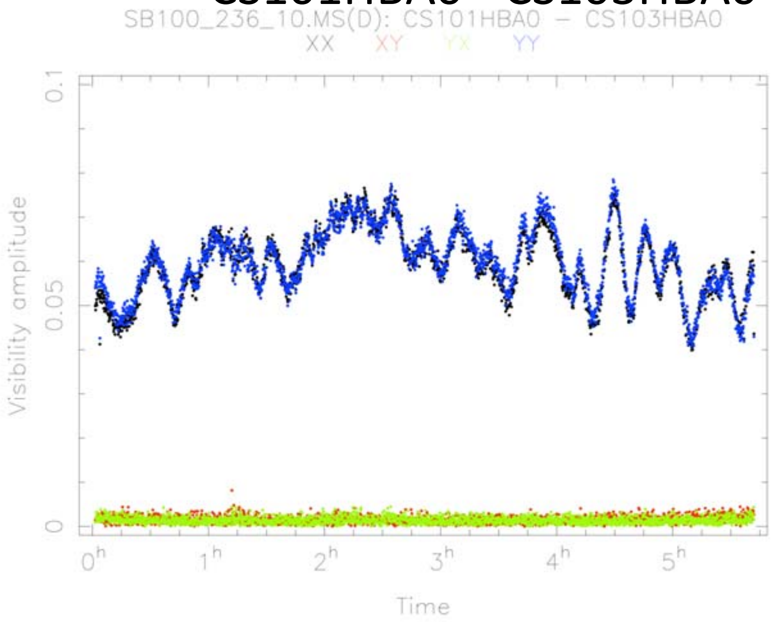
The variable S/N must, at least in part, be due to the variable number of failing tile modems. So to get an estimate of good behaviour I picked a pair of baselines that involved stations with (until now) still very few tile modem failures

CS101HBA0-CS103HBA0 (24 tiles each with one tile-modem failure)

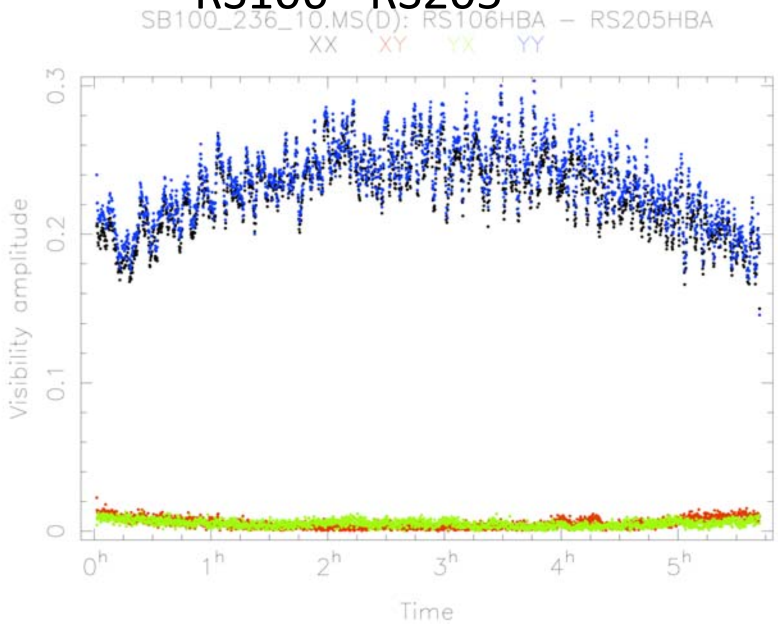
RS106-RS205 (48 tiles with one tile-modem failure in RS205)

Long 6h tracks 135 MHz 3C196

CS101HBA0 - CS103HBA0



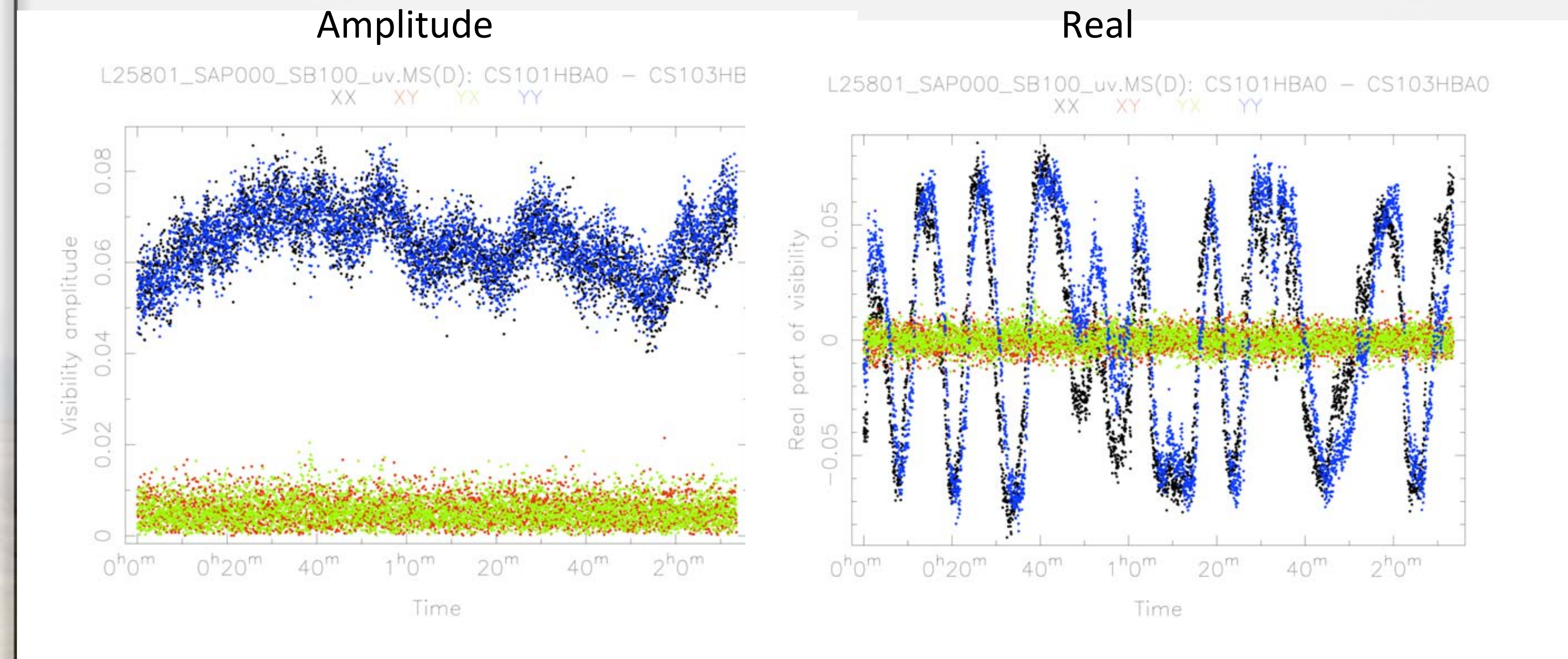
RS106 - RS205



The XX and YY signals reflect the ~ 83 Jy source 3C196 and its mucht fainter companion. The XY , YX signals still have a variable leakage component (and possibly some DFR).

So to determine the noise form XY and YX we need to go to shorter dt and df

CS101-CS103 data: ~2h around transit at 2s

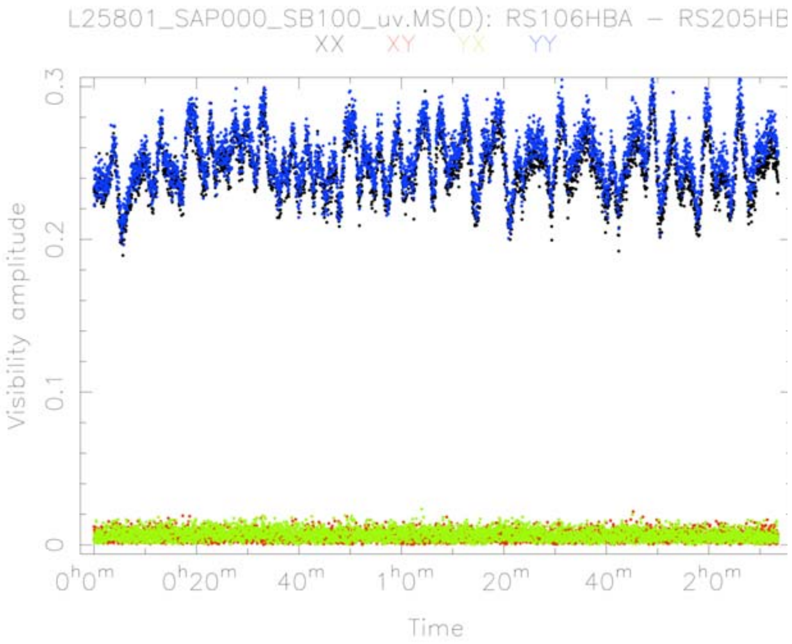


In dt=2s and df = 16ch (48.6 kHz) we find a S/N =14.3
For a flux density of S = 83 Jy → noise ~ 5.8 Jy

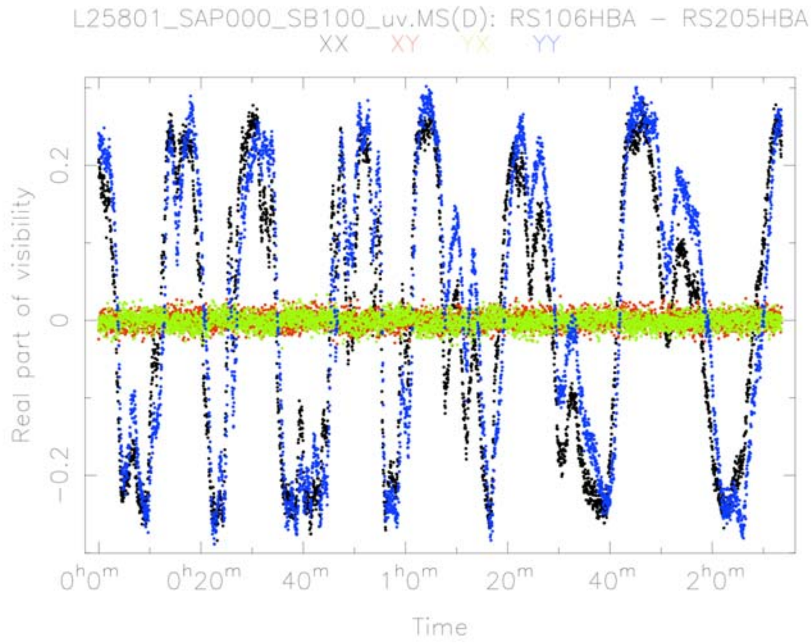
→ SEFD = 5.8 Jy * SQRT(2.dt.df) ~ 2557 Jy (24 tiles)

RS106-RS205 data: ~2h around transit at 2s

Amplitude



Real



In dt=2s and df = 16ch (48.6 kHz) we find a S/N = 27.7
For a flux density of S = 83 Jy → noise ~ 3.00 Jy

→ SEFD = 3.00 Jy * SQRT(2.dt.df) = 1321 Jy (48 tiles)

Variation of S/N on RS106-RS205 for same range dt,df

7 Jan 2011	L22667	SB100	S/N = 18.6
28 Jan 2011	L23092	SB100	S/N = 17.0
11 Mar 2011	L23927	SB100	(S/N > 14.8)
19 Mar 2011	L24380	SB101	S/N = 24.1
1 Apr 2011	L24837	SB100	S/N = 28.3
15 Apr 2011	L25489	SB100	S/N = 20.0
29 Apr 2011	L24801	SB100	S/N = 27.7

Conclusions

- The noise levels observed on CS-CS and RS-RS baselines are derived from cross-polarization signals on good stations in the direction of 3C196 (cold Galactic halo).

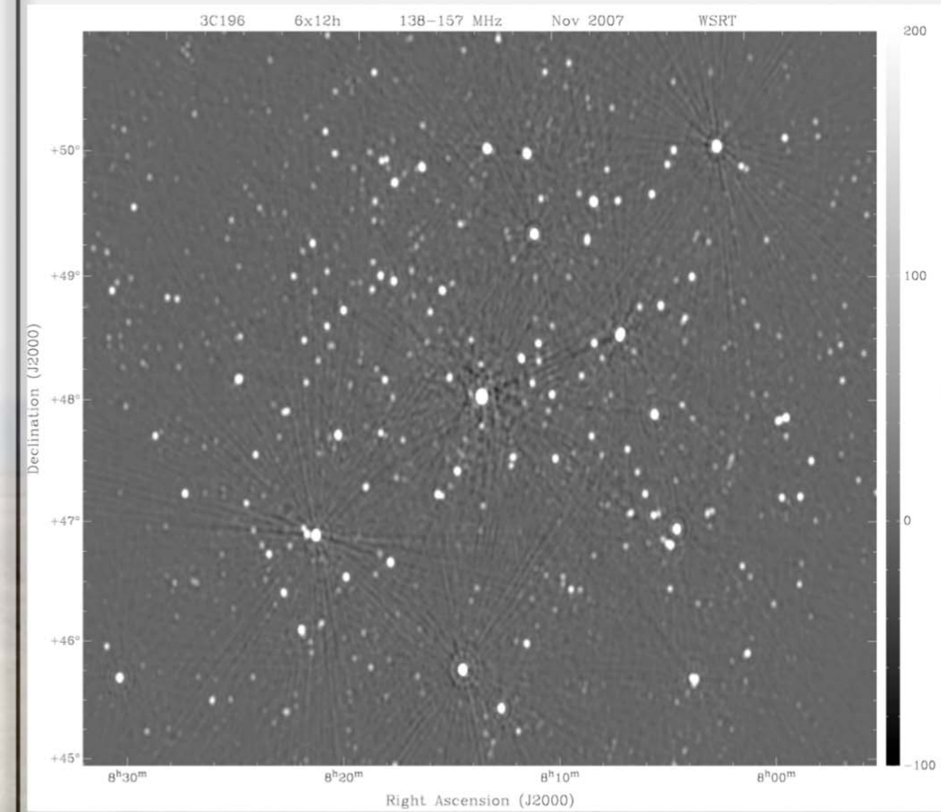
- The results imply SEFDs of about 2600 Jy (CS) and 1300 Jy (RS) at 135 MHz.
This is about 20% better than given on the LOFAR sensitivity tables (Nijboer et al,)
Different values can be expected in different parts of the Galactic halo.

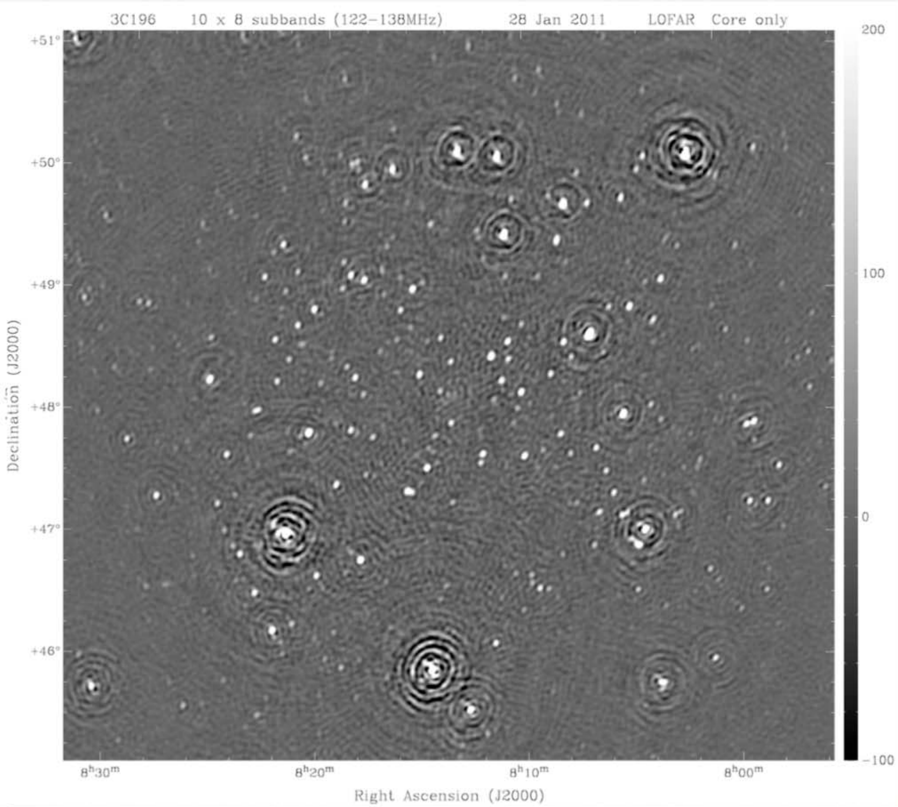
- On a given baseline (e.g. RS106-RS205 or CS101-CS103) the SEFD varies by about a factor 1.5 from epoch to epoch. This is still not understood.

-Based on this noise we expect in a standard image a thermal noise after 6h of about 2 mJy. The observed noise in a single 6h-image, for one subband, is about 15 mJy (Stokes I) and 4 mJy in Stokes Q,U,V.

- A recent image on next slide

Comparison WSRT and LOFAR 120-150 MHz images





WSRT 72h thermal noise 0.6 mJy
confusion noise 3 mJy

LOFAR 6h thermal noise ~0.2 mJy
(sidelobe noise) 4 mJy

CS only !

80 subbands: BBS with only 3C196 !

Still DDE's for beamvariation required